

Fig. B  
9. (Amended) A gas separation apparatus according to claim 1, wherein the plurality of chromatographic columns are supplied with feed gas which is sequentially switched among the plurality of chromatographic columns thereby sequentially changing the function of each column.

10. (Amended) A gas separation method for separating at least one specific gas from a gas to be treated containing a plurality of specific gases, said method comprising the steps of:

a first separation step for separating said gas to be treated into gas groups having different boiling points by distillation separation; and

a second separation step for separating the at least one specific gas by performing chromatographic separation on at least one gas group that is separated through distillation at the first separation step,

wherein the second separation step comprises sequentially supplying a plurality of chromatographic columns with the at least one gas group by switching an inlet valve for each of the plurality of chromatographic columns and sequentially collecting the at least one specific gas from the plurality of chromatographic columns by switching a plurality of outlet valves.

#### REMARKS

Please reconsider the application in view of the above amendments and the following remarks. The Applicants thank the Examiner for carefully reviewing the application. In view of the following remarks, the Applicants believe all claims to be in condition for allowance.

#### **I. Disposition of Claims**

Claims 1-17 are pending the application. Claims 1 and 10 are independent claims. Claims 1, 9, and 10 have been amended to more clearly define the Applicants' invention. No new matter has been added by way of these amendments. Support for a plurality of chromatographic columns and valve can be found, for example, in the specification pages 7-8 and Figure 2.

## II. Claim Rejections under 35 U.S.C. §102

Claims 1, 2, 10, and 11 were rejected under 35 U.S.C §102(b) as being anticipated by either European Patent Application No. EP 0 948 988 A1 ("Kazuyoshi") or U.S. Patent No. 4,254,062 ("Wambach"). To the extent that this rejection may apply to the amended claims, it is respectfully traversed.

The Applicants' invention relates to a gas separation apparatus in which a gas mixture that includes a plurality of specific gases is separated into at least one specific gas. In one or more embodiments, the gas is a perfluoro compound (PFC), which is a mixture containing fluorine compounds, *e.g.*, CF<sub>4</sub>, NF<sub>3</sub>, C<sub>2</sub>F<sub>6</sub>, CHF<sub>3</sub>, *etc.* In one example, the claimed invention separates one of the fluorine compounds.

As recited in amended claim 1, a gas separation apparatus in accordance with one embodiment of the invention includes a first separator, which separates a plurality of specific gases into gas groups based on different boiling points by distillation separation. (See, *e.g.*, pages 4 and 5 of the specification.) In one or more embodiments, a first gas group, which includes CF<sub>4</sub> and NF<sub>3</sub>, is separated because boiling points of these gases are substantially the same (approximately -128 °C). A second gas group, which includes C<sub>2</sub>F<sub>6</sub> and CHF<sub>3</sub>, is also separated because the boiling points of these gases are also substantially the same (approximately -80 °C).

Additionally, the gas separation apparatus includes a second separator, which separates the at least one specific gas from at least one of the gas groups separated by the first separator by chromatographic separation. (See, *e.g.*, pages 5 and 6 of the specification.) Continuing the example, the first gas group, *i.e.*, CF<sub>4</sub> and NF<sub>3</sub>, are separated from the chromatographic separators into the respective specific gases for reuse.

Further, the second separator includes a plurality of chromatographic columns. In one embodiment, the plurality of chromatographic columns are supplied a gas group in sequence, *i.e.*, the first gas group is "introduced" to the columns by switching in order an inlet valve. The introduced gases will flow out in a particular order and can be separated and discharged by switching a valve at the exit side (or outlet valve). (See, *e.g.*, page 7 of the specification.) Advantageously, the Applicants' invention allows specific gases to be collected continuously, inexpensively, and with high purity.

As amended claim 1 includes the limitation that “wherein the second separator comprises a plurality of chromatographic columns, wherein the plurality of chromatographic columns each comprises at least one inlet valve and a plurality of outlet valves arranged such that the at least one gas group is sequentially provided to the plurality of chromatographic columns by switching the at least one inlet valve and the at least one specific gas is sequentially collected from the plurality of chromatographic columns by switching the plurality of outlet valves.” Similarly, the amended claim 10 includes the limitation that “wherein the second separation step comprises sequentially providing a plurality of chromatographic columns with the at least one gas group by switching an inlet valve for each of the plurality of chromatographic columns and sequentially collecting the at least one specific gas from the plurality of chromatographic columns by switching a plurality of outlet valves.”

In contrast, Kazuyoshi and Wambach do not disclose a second separator that includes a plurality of chromatographic columns, “wherein the plurality of chromatographic columns each comprises at least one inlet valve and a plurality of outlet valves arranged such that the at least one specific gas is sequentially collected from the plurality of chromatographic columns by switching the plurality of outlet valves,” as recited in amended claim 1. The Examiner acknowledges that Kazuyoshi and Wambach do not teach this limitation. (See paragraph 6 on page 3 of the Action.)

Because Kazuyoshi and Wambach fail to disclose a plurality of chromatographic columns as required by amended claims 1 and 10, claims 1 and 10 are patentable over Kazuyoshi and Wambach. Thus, claims 2 and 11, being dependent either directly or indirectly from claim 1 or 10, are likewise patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

### **III. Claim Rejections under 35 U.S.C. §103**

Claims 3-8 and 12-17 were rejected under 35 U.S.C. §103(a) as being unpatentable over Kazuyoshi or Wambach in view of European Patent Application No. EP 0 924 485 A1 (“Takashi”), EP 0 854 335 A2 (“Bao”), or EP 0 500 040 A1 (“Henderson”). To the extent that this rejection applies to the amended claims, it is respectfully traversed.

Takashi, Bao, and Henderson each disclose purifying fluorine compounds for reuse. However, these references are completely silent as to a separator that includes a plurality of chromatographic columns as recited in amended claims 1 and 10.

Because Takashi, Bao, and Henderson fail to teach or suggest that which Kazuyoshi and Wambach lack, namely, a plurality of chromatographic columns, claims 1 and 10 are patentable over Kazuyoshi, Wambach, Taksahi, Bao, and Henderson, whether considered separately or in combination. Claims 3-8 and 12-17 depend, directly or indirectly, from claims 1 and 10. These claims are likewise patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

Claim 9 was rejected under 35 U.S.C. §103(a) as unpatentable over Kazuyoshi or Wambach in view of International Application No. WO 99/33540 ("Kaneko"). Claim 9 has been amended in this reply and is dependent on amended claim 1. To the extent that this rejection may apply to the amended claim 9, it is respectfully traversed.

Kaneko fails to provide that which Kazuyoshi and Wambach lack with respect to amended claim 1. In particular, Kaneko teaches a chromatographic separation process for separating a fluid with three components. In particular, Kaneko states:

...an endless circulation system (loop) made up of a plurality of packing bed units packed with chromatographic packing (sorbent) and linked endlessly to flow the starting fluid material and the desorbent in one direction through the endless circulation system and withdrawing fractions from zones enriched with respective components out of the endless circulation system while taking advantage of a phenomenon that a plurality of components to be separated...due to a difference between components in affinity for chromatographic packing...(p. 2, ll. 8-16 of Kaneko).

The endless circulation system as disclosed by Kaneko is "a system comprising a plurality of packing beds linked in endless *series* and packed with solid sorbent," (page 9, ll. 31-33 of Kaneko). For example, in Figure 1, piping (21) of the system is fed to chromatographic column 1, the "output" of chromatographic column 1, *i.e.*, the fluid separated by

chromatographic column 1, may be collected by outlet valves (1A or 1C). Additionally, the output of chromatographic column 1 is supplied to chromatographic column 2, and subsequently separated. The output of chromatographic column 2 may be collected by outlet valves (2A, 2C), and supplied to chromatographic column 3, and so on. In other words, "[t]he ends of the packing bed units 1 to 10 are endlessly linked with the tops of respective next packing bed units by means of connecting pipings 20 and 21," (page 11, ll. 34-36.) Therefore, *series* in Kaneko refers to the *physical* fluid communication between the chromatographic columns.

In contrast, in the present invention, as recited in claims 1 and shown in Figure 2, the gas group is supplied *in sequence* (or *sequentially*) to a plurality of chromatographic columns arranged in *parallel* and the specific gas is collected *in sequence* (or *sequentially*) from a plurality of chromatographic columns. As stated in the instant specification, "the first gas group is supplied to each column in sequence and each fraction is collected from each column in sequence," (page 7, ll. 4-6). A specific gas will be separated from the columns in a particular order, depending on their relative affinity for the column packing material. That is, *in sequence* relates to a *temporal* staggering with respect to supplying a gas group or collecting a specific gas by timing the switching of an inlet or outlet valve. In Figure 2 of the original application, the ends of the chromatographic columns are *not* connected to the tops of the adjacent chromatographic columns as in Kaneko's Figure 1. In fact, chromatographic columns (1a- 1d as shown in Figure 2) share a piping for a carrier gas and a piping for a gas mixture to be supplied. Additionally, the chromatographic columns share a piping for respective gases to be collected. However, the output of one chromatographic column is *not* supplied to an adjacent chromatographic column as in Kaneko.

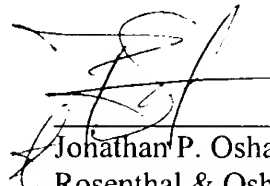
Therefore, Kaneko does not disclose supplying a gas group in sequence and collecting a specific gas in sequence as recited in claim 1, rather Kaneko teaches a chromatographic separation process that occurs in physical series. Thus, Kaneko fails to teach or suggest that which Kazuyoshi and Wambach lack with respect to claim 1. Therefore, claim 1 is patentable over Kaneko, Kazuyoshi and Wambach, whether considered separately or in combination. Claim 9 depends from claim 1, and, thus, is likewise patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

#### IV. Concluding Remarks

Applicants believe this reply to be fully responsive to all points raised in the Office Action dated November 8, 2002. If this belief is incorrect, or other issues arise, please do not hesitate to contact the undersigned or his associates at the telephone number listed below. Please apply any charges not covered, or any credits, to Deposit Account 50-0591 (Reference Number 08228.018001).

Respectfully submitted,

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Marked-Up Version of Claims

IN THE CLAIMS:

1. (Amended) A gas separation apparatus for separating at least one specific gas from a gas to be treated which contains a plurality of specific gases, said apparatus comprising:

a first separator for separating said gas to be treated into gas groups having different boiling points by distillation separation; and

a second separator for separating the at least one specific gas[es] by performing chromatographic separation on at least one gas group separated by said first separator,

wherein the second separator comprises a plurality of chromatographic columns,

wherein the plurality of chromatographic columns each comprises at least one inlet valve and a plurality of outlet valves arranged such that the at least one gas group is sequentially supplied to the plurality of chromatographic columns by switching the at least one inlet valve and the at least one specific gas is sequentially collected from the plurality of chromatographic columns by switching the plurality of outlet valves.

9. (Amended) A gas separation apparatus according to claim 1, wherein [said second separator comprises a] the plurality of chromatographic columns [; the column into which] are supplied with feed gas [flows] which is sequentially switched among the plurality of chromatographic columns [; and] thereby sequentially changing the function of each column [is sequentially changed].

10. (Amended) A gas separation method for separating at least one specific gas from a gas to be treated containing a plurality of specific gases, said method comprising the steps of:

a first separation step for separating said gas to be treated into gas groups having different boiling points by distillation separation; and

a second separation step for separating the at least one specific gas[es] by performing chromatographic separation on at least one gas group[s] that is [distillation] separated through distillation at [said] the first separation step,

wherein the second separation step comprises sequentially supplying a plurality of chromatographic columns with the at least one gas group by switching an inlet valve for each of the plurality of chromatographic columns and sequentially collecting the at least one specific gas from a plurality of chromatographic columns by switching a plurality of outlet valves.